DEA RESEARCH DISCUSSION PAPER
Number 54
February 2003

The contribution of minerals to sustainable economic development: Mineral resource accounts in Namibia

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Edited by Helen Suich
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I would like to thank many people who assisted in providing data and valuable suggestions, in particular Ndamona Kali, Jonathan I. Barnes, and Matthew Wright. The author is responsible for all opinions expressed in this report.
This work was supported in part through funding from the Swedish International Development Cooperation Agency and the United States Agency for International Development.

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Acronyms

GDP	gross domestic product
SAMREC	South African Mineral Resources Committee
SBI	Sustainable Budget Index
SEEA	System of Integrated Economic and Environmental Accounting
SNA	1993 System of National Accounts

Abstract

This report addresses the issue of sustainable development in an economy dependent on mineral resources, a non-renewable resource. Mineral wealth can provide countries with a tremendous opportunity for economic development by providing the funding for investment and growth. However, resource abundance does not necessarily lead to economic prosperity for a variety of reasons. As a group, resource-rich developing countries have performed worse, economically, than resource-poor developing countries over the past 30 years, a phenomenon known as the 'resource curse'.

Mining is a critical sector of the Namibian economy and mineral assets form a major source of national wealth. But the national accounts give a distorted picture of economic health because they record the contribution of mining to gross domestic product but not the simultaneous depletion of mineral wealth. Environmental and natural resource accounts overcome this limitation, providing accounts for the value of mineral reserves and the cost of depletion. In this way, policy-makers can anticipate and plan for the eventual exhaustion of mineral assets. Physical and monetary accounts are constructed for Namibia's three major minerals – diamonds, uranium and gold – based on the United Nation's System for Integrated Environmental and Economic Accounts.

The accounts are used to assess the extent to which minerals are being used to build a sustainable economy. Sustainable development requires recovery of resource rent generated by mining, and investment of this rent in other forms of wealth, capable of generating income and employment once minerals are depleted. Namibia has recovered, on average, about 42 per cent of diamond rents over the past 20 years. This is reasonable, though much lower than rent recovery in Botswana (76 per cent). However, where the two countries differ most is in management of mineral revenues. Botswana has an explicit policy of reinvestment by government of all mineral revenues in public infrastructure, human capital and foreign financial assets. While Namibia has carefully considered how mining may contribute to current employment and the economy of specific regions of the country, it has yet to develop a policy for reinvestment of mineral revenues. Only through building national wealth can minerals contribute to long-term sustainable development.

1. INTRODUCTION: MINERALS IN THE NAMIBIAN ECONOMY

Minerals are a principle source of income for many developing countries, including many in southern Africa. At first glance, mineral-rich economies have an advantage over those less well endowed because minerals provide funds for rapid development and poverty reduction. However, resource abundance does not necessarily lead to economic prosperity for a variety of reasons. Governments are frequently under considerable pressure to spend mineral revenues on current consumption rather than to invest revenues. This is particularly the case in developing countries, where many basic needs remain unmet and rent-seeking behaviour by individuals and interest groups may be especially difficult to resist. As a result, mineral wealth can detract from, rather than enhance, economic performance.

As a group, resource-rich developing countries have performed worse economically than resource-poor developing countries over the past 30 years[1] (Table 1), a phenomenon known as the 'resource curse' (Auty and Mikesell, 1998; Sachs and Warner, 1995). It is hoped that this report will shed some light on policies that can be implemented to avoid the resource curse in Namibia.

Table 1 Resource endowments and economic growth in developing countries

	Number of countries	Annual per capita GDP growth 1960–1990 (%)
Resource-rich		
Large economies	10	1.6
Small economies, exports dominated by:	55	1.1
Non-mineral resources	31	1.1
Mineral ores	16	0.8
Petroleum and natural gas	8	1.7
Resource-poor		
Large economies	7	3.5
Small economies	13	2.5
All countries	**85**	**1.6**

Source: Based on Auty and Mikesell, 1998.

1.1 Namibia's mineral economy

Mining has played a vital role in the economic development of many southern African countries, including Namibia and Botswana. Namibia's mining industry developed relatively early, based mostly on diamonds discovered at the turn of the century (Hartmann, 1986). The initial reserves were high quality gem diamonds extracted from relatively inexpensive on-shore mining sites. Other metals (mainly copper, zinc, lead) were exploited in the post-World War II period, and uranium mining began in the early 1970s. In the late 1980's Navachab gold mine opened up.

By the 1990's, Namibia's mining industry appeared largely depleted. The main copper mines shut down in 1998, most of the on-shore diamond reserves have been exhausted and mining has moved

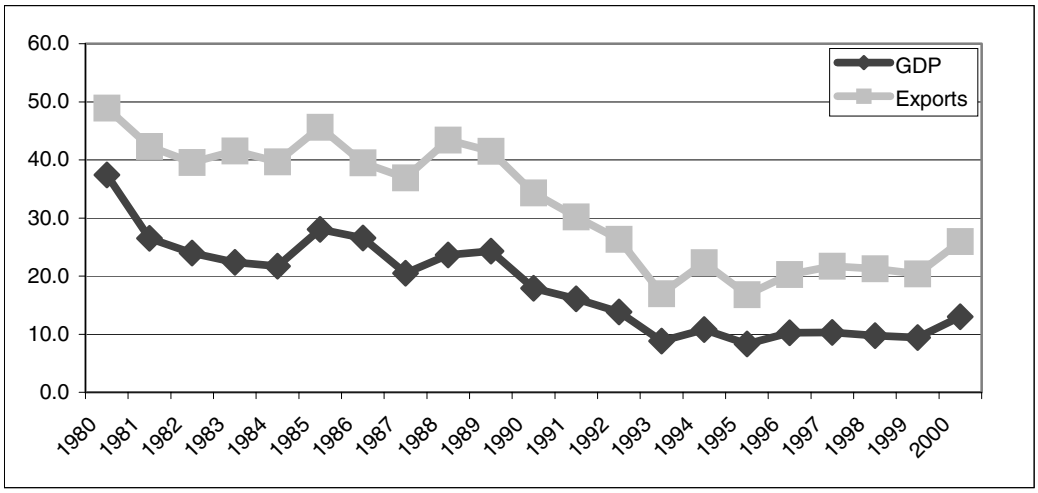
[1] While this may also be true in industrialised countries, the dependence of these economies on non-renewable resources is often much lower than in the developing countries under consideration, hence, the management of this wealth is less critical.

much of its operations to off-shore reserves. Although off-shore reserves appear to be abundant, they are much more expensive to mine. The global outlook for uranium has not been good for some time, so that although the reserves have not yet been exhausted, there is not a strong market for uranium. For a few years, it appeared that off-shore natural gas fields would be developed, which would have helped Namibia meet its energy requirements, but the fields will not be developed in the foreseeable future (USGS, 2001)

In 2000, however, Namibia's mining industry outlook was substantially better. The copper mine and smelter at Tsumeb reopened in 2000, along with the copper mines at Kombat and Otjihase. Skorpion zinc mine is under development with production expected for 2003. Continued exploration for diamonds, both off-shore and in the northeastern part of the country that borders Botswana have yielded positive results.

In earlier years, mining was the single largest component of the Namibian economy, accounting for nearly 40 per cent of GDP and 50 per cent of exports in 1980 (Figure 1). Although its importance has since declined, mining still accounted for 13 per cent of GDP and 26 per cent of exports in 2000 (CBS, 2001). The most recent Labour Force Survey, for 1997, indicates that mining employs roughly two per cent of the formal labour force (Ministry of Labour, 2000).

Figure 1 Contribution of mining to GDP and exports in Namibia, 1980 to 2000 (percent)



Source: CBS, 1996; 2001.

1.2 Minerals and sustainable development: An environmental accounting approach

Clearly, mining is still a critical sector of the Namibian economy and mineral assets form a major source of national wealth. At this time, however, the statistical offices compile asset accounts only for manufactured capital, which includes buildings, construction works, machinery and equipment; the value of natural capital is omitted. This omission is problematic because minerals are non-renewable resources that are gradually being depleted, even though the economic life of mineral resources can be extended by new discoveries or new extraction technologies. Mining generates income (which is included in the national accounts and economic indicators like gross domestic product (GDP)), but at the same time depletes national wealth by using up the limited supply of mineral assets. The national economic accounts, thus, give a distorted picture of economic health because they report the contribution of mining to GDP but not the simultaneous depletion of mineral wealth.

To correct this omission, the most recent revision of the national accounts, the 1993 System of National Accounts (SNA) (United Nations, 1993a), proposed including minerals in the asset accounts. Strengthening and expanding the inclusion of natural capital, environmental accounts were proposed by the United Nations (UN, 1993b; 2002) as a set of satellite accounts to the SNA in order to provide a more accurate picture of the extent to which the economy relies on natural capital and, with regard to minerals, the economic implications of the rate at which this capital is being depleted (or increased when new discoveries are made). In this way, policy-makers can anticipate and plan for the eventual exhaustion of mineral assets.

With respect to minerals, the environmental accounts estimate the economic value of mineral wealth, the cost of depletion, and the extent to which mineral wealth is being used to promote sustainable economic development. The present value of mineral assets is the discounted value of resource rent that a mineral will earn over its lifespan. Briefly, the economic rent, or resource rent, is an income earned from resources, such as minerals, in excess of the costs of extraction (including a 'normal' return to capital). Rent is attributable to the scarcity of the resource and is a measure of the value of the resource. (Rent is discussed in greater detail in sections 2 and 3.)

The recovery of resource rent by the government is essential for sustainable economic development. For non-renewable resources like minerals, taxing resource rent and reinvesting part of the rent in other economic activities is necessary to provide alternative sources of income and employment once the minerals are exhausted. The goal is to sustain income over time, even though the resource itself is not sustainable, by substituting other economic activities for mining. Hence, a major purpose of the environmental accounts is not simply to monitor total assets of the country, but to monitor whether the objectives of sustainable development are being achieved and to shed light on how alternative management of resources might enhance sustainable development.

This report addresses the issue of sustainable development in an economy dependent on mineral resources, a non-renewable resource. Section 2 describes the mineral accounts, explains the methodology used to measure rent and the economic value of mineral assets. Section 3 presents the mineral accounts, physical and monetary, over the period 1980 to 2001. Accounts are constructed for diamonds, uranium and gold but confidentiality constraints prevent disclosure of the complete accounts for each mineral. Section 4 discusses the policy implications of the accounts in terms of two criteria for sustainable development: recovery of resource rent through taxes and reinvestment of resource rent in other assets. The mineral accounts of Botswana are presented to provide an example of an alternative approach to resource management. Concluding remarks are provided in the final section.

2. METHODOLOGY AND DATA SOURCES

2.1 Structure of environmental accounts

Environmental and resource accounts have evolved since the 1970s through the efforts of individual countries and practitioners, each developing their own frameworks and methodologies to represent their environmental priorities. Since the late 1980s, concerted efforts have been underway through the United Nations Statistics Division, the European Union, the OECD, the World Bank, country statistical offices, and other organizations to standardize the framework and methodologies. The United Nations published an interim handbook on environmental accounting called the System of Integrated Economic and Environmental Accounting (SEEA) in 1993 (UN, 1993b), which has been revised in 2002 (UN, 2002). The mineral accounts for Namibia and Botswana are based on the SEEA.

Many countries are now compiling mineral accounts, which are included in the national accounts under the asset accounts as non-produced assets. Relative to other resources, minerals are probably the most commonly constructed set of accounts. Table 2 shows the countries with official environmental accounting programmes and the most important minerals in their asset accounts. There have been one-time consultancy reports and academic studies as well, but these are too numerous to include here. Both industrialised and developing countries compile mineral accounts and, not surprisingly, mineral accounts are compiled in countries where minerals play an important economic role. Accounts for petroleum and natural gas predominate.

Table 2 Countries that construct mineral accounts

Country	Minerals included in the sub-soil asset accounts
Australia	bauxite, diamonds, lead, coal, zinc, petroleum, natural gas, uranium
Botswana	diamonds, copper-nickel, coal
Canada	petroleum, natural gas, coal, metals (copper, zinc, nickel, lead, gold, silver, molybdenum, iron, uranium),potash
Chile	copper, gold, coal, calcium carbonate
Denmark	petroleum, natural gas
France	petroleum, natural gas
Indonesia	petroleum, natural gas
Mexico	petroleum
Netherlands	petroleum, natural gas
Norway	petroleum, natural gas
Philippines	gold, silver, cobalt, copper lead, chromite, molybdenum, zinc, nickel, iron, manganese
South Africa	coal, gold, platinum
UK	petroleum, natural gas
US	petroleum, natural gas, coal metals (iron ore, copper, lead, zinc, gold, silver, molybdenum) other minerals (phosphate rock, sulfur, boron, diatomite, gypsum, potash)

Source: Based on Lange, 2002a.

Although Namibia mines a wide range of minerals, a few minerals account for virtually all the economic contribution. Presently, diamonds, uranium and gold account for more than 95 per cent of Namibia's mining GDP and mineral accounts have been compiled only for these minerals. The zinc mine, expected to begin production in 2003 and the newly reopened copper mine at Tsumeb will be included in future mineral accounts.

Natural resource asset accounts follow the general structure of the accounts for fixed assets in the SNA, with data for opening stocks, closing stocks, and changes during the year (Figure 2). Changes include extraction, new discoveries and other volume changes, which includes redefinition of reserves due to changes in price or extraction technology, for example. The monetary accounts for resources have an additional component, like manufactured capital, for revaluation.

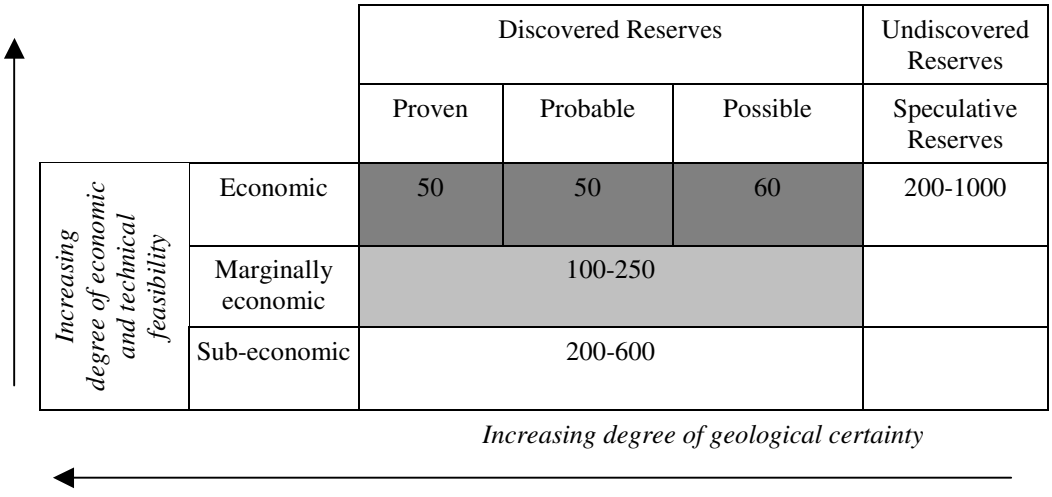
Figure 2 Structure of mineral asset accounts

	Physical Accounts	Monetary Accounts
Opening Stocks	X	X
Changes in Stocks	X	X
- Extraction	X	X
+ New discoveries	X	X
+ Other volume changes	X	X
Revaluation (monetary accounts only)		X
Closing Stocks	X	X

2.2 Physical accounts: Methodology and data sources

Measurement of the physical stocks can present problems both in terms of what to measure as well as how to measure. The mining industry has developed a system, referred to as the McKelvey Box, to classify mineral reserves according to combined criteria of geological certainty (proven/probable/possible/undiscovered reserves) and economic feasibility of extraction (economic/ marginally economic/sub-economic reserves) (Figure 3). In the example of Figure 3, 50 thousand tons of ore are shown to be proven reserves (90%+ probability) that are profitable to mine at the current market price and the cost of extraction. Reserves that are both proven plus economic are referred to as economically proven reserves. Another 50 thousand tons may be probable (e.g., 50-90% probability) and 60 thousand tons possible (less than 50% probability). Marginally economic reserves are estimated at 100–250 thousand tons and sub-economic reserves – not profitable to mine with the present price and technology – may be estimated at 200–600 thousand tons.

Figure 3 Example of a McKelvey Box to classify mineral reserves



A modified version of the McKelvey Box system of classification was established by the South African Mineral Resources Committee (SAMREC) as part of a code for public company reporting in South Africa. This system is used by all the diamond mining companies in Namibia. The SAMREC code identifies two categories: reserves and resources. Reserves include proven and probable reserves, corresponding roughly to the classification of the McKelvey Box. Resources include indicated and inferred mineral deposits which correspond roughly to possible and speculative reserves.

There has been some controversy over whether mineral accounts should include only economically proven reserves, or whether both proven and probable reserves should be valued. In the past, most countries included only proven reserves because of the difficulties in valuing probable reserves. The costs of extraction and, hence, the per-unit rent for probable reserves may differ significantly from extraction costs for proven reserves.

Increasingly, countries are including other categories of reserves, weighted by their probability of economic extraction, because omission of these reserves gives a misleading picture of the mineral assets. For example, the proven petroleum reserves of UK have shown no depletion for the last 20 years, despite massive extraction (Harris, 2000). Even when probable reserves were added to proven reserves, no depletion was seen. Only when all three categories of reserves – possible, probable, and proven – were included could the depletion of reserves due to extraction be seen. This is because depletion of proven reserves was constantly being offset by further development of probable and possible reserves which added to proven reserves. 'Proving' reserves – undertaking the exploration and development necessary to move reserves from probable or possible into proven – is expensive and companies do not undertake this expense until it is profitable for them to do so, i.e. when the current level of proven reserves has declined sufficiently to require a decision about the future of the mine.

The SEEA recommends that mineral accounts include economically proven, possible and even probable. In practice, the category of reserves included depends on the information available for each mineral.

2.2.1 Namibian data sources

In Namibia, annual figures for extraction are published by the Ministry of Mines and Energy. No figures on reserves are collected or published so a survey was undertaken that requested data for economically proven reserves, changes in reserves, new discoveries, as well as information about annual investment since the opening of the mine in order to compile the monetary accounts.

The survey was sent out to the four companies that mine Namibia's three major minerals. Uranium has been mined by one company at a single location since the mine was first opened in the early 1970s. Gold mining is also limited to one company in a single location. Two companies mine virtually all diamonds: Namdeb, the partnership between the government of Namibia and DeBeers mining company, accounted for 86 per cent of production in 2000, and Namibian Minerals Corporation (NAMCO, formerly Ocean Diamond Mining) accounted for almost all remaining production (14 per cent), with other companies accounting for less than one per cent of production (USGS, 2001). Several new companies, such as Trans-Hex, are quite active in diamond exploration and will be included in future industry surveys.

Because of confidentiality requirements, information about reserves for individual minerals cannot be published. However, there is a new spirit of openness and transparency in the mining industry, particularly diamond mining. Since 1999, DeBeers' *Annual Report* has published figures for reserves and production at all its mines, including those in Namibia. With the expansion of reserves in 2000, Namdeb expects a lifespan of its operations at current production levels (in 2000) for roughly 20 years. It is hoped that in the future, it will be possible to publish complete mineral accounts including information about reserves.

2.3 Monetary accounts: Methodology and data sources

Monetary accounts are constructed by estimating the value of the physical asset. The value of mineral reserves is the net present value of the stream of income they are expected to generate in the future. The stream of income that is attributable solely to the resource is called the resource rent. Constructing monetary accounts, thus, has two components: measuring resource rent and making projections about the factors that will affect the future stream of rent.

2.3.1 Measuring resource rent

Resource rent is an income earned from resources, such as minerals, in excess of the costs of extraction (including a 'normal' return to capital). Rent is attributable to the scarcity of the resource and is a measure of the value of the resource. Where markets for resources exist, such as auction markets for fish quotas, the trading prices can, under the right circumstances, reflect the rent. Where such markets are lacking, the SEEA recommends calculating rent as the value of output minus the costs of production, as shown in Box 1. (Appendix 1 provides all the data used to calculate resource rent and goes through the calculation for one year to demonstrate how the equations are implemented.)

There are several qualifications to this method of estimating rent that should be noted. This estimate of rent is based on the private costs of extraction. The social costs of extraction, and hence the social value of rent may diverge from the private value for several reasons. First, wages may be artificially high in the mining sector, above the shadow wage rate, especially for unskilled labour. This would have the effect of increasing private costs above social costs and reducing the private value of rent relative to the social value of rent. Since labour costs are rather small in the highly capital-intensive mining operations, this effect is probably quite small and can be ignored.

Box 1 Calculating resource rent

Rent is calculated each year for each mineral using the following formula:

(1) $R^i = TR^i - (IC^i + CE^i + CFC^i + NP^i)$

(2) $NP^i = \pi \times K^i$

where R is Resource rent
TR is Total revenue
IC is Intermediate consumption
CE is Compensation of employees
CFC is Consumption of fixed capital
NP is Normal profit
π is rate of return on fixed capital
K is the value of fixed capital stock invested in the industry

for each mineral, i, where i = 1,2,3 for diamonds, uranium, and gold, respectively.

In actual implementation, average cost is used rather than marginal cost because data about marginal costs are not generally available. This practice introduces an upward bias into the measure of rent when average cost is lower than marginal cost.

All data used in the calculations are obtained from the national accounts except for π, the opportunity cost of capital. In practice, the opportunity cost, or 'normal profit' as it is also known, is difficult to measure and is, therefore, often defined as either the average return on capital in an economy or the average cost of borrowing capital, adjusted for risk. A 10% rate of return was used, based on government guidelines for project evaluation.

The second source of divergence between the private and social value of rent results from government investment in fixed capital, including infrastructure, necessary for mining. In the national accounts, these capital costs are not associated with the mining industry, hence, the capital costs (return to fixed capital and depreciation) of mining may be underestimated to some extent. The omission of government investment reduces the private costs of mining and increases the

private value of rent relative to the social value. For diamond mining, because rent is large relative to extraction costs, the inclusion of government investment would probably not make much difference. However, for other minerals, the inclusion of capital costs incurred by government could push the extraction costs high enough to result in near zero or negative rents for most years. It is not possible at this time to estimate how large an impact this would have on the private rent estimates calculated here, but would be useful in future work on the mineral accounts.

Finally, mining may cause substantial environmental damage, such as air and water pollution and the disruption of natural habitat. While pollution seems to be a minor issue in Namibia, there is great potential for damage to fragile and unique natural habitats both from mining operations themselves, as well as from the infrastructure – roads, railways – necessary for the exploitation of their minerals. Including such costs would reduce the value of rent and of the asset, but there are no estimates of these costs at present.

2.3.2 Projecting future resource rent

The value of each mineral reserve is the net present value of all the rent it will generate in the future, which is described in Box 2.

Box 2 Calculating mineral asset value

The NPV formula for calculating the value of mineral assets V at period τ is:

(3) $$V_\tau^i = \sum_{t=\tau}^{T} \frac{p_t^i Q_t^i}{(1+r)^t}$$

(4) $$p_t^i = \frac{R_t^i}{Q_t^i}$$

(5) $$T_t^i = \frac{S_t^i}{Q_t^i}$$

where T is the remaining lifespan of the resource
Q is the quantity extracted
p is the unit rent
r is the discount rate
S is the remaining physical stock,
and other variables are defined as in Box 1.

for each mineral, i, where i = 1,2,3 for diamonds, uranium, and gold, respectively.

A number of assumptions are required for implementing this formula: a) future levels of extraction, Q, b) expected future per unit rent, p, and c) the discount rate, r. Ideally, information about planned future extraction, expected production costs and market prices for the mineral would be obtained from mining companies and used for the calculation. However, in most instances this information is lacking, so, at the recommendation of the SEEA, it is usually assumed that both the volume of extraction and the per unit rent remain constant over time. In calculating the asset value another assumption must be made about the social discount rate to apply to future rent; a rate of 10 per cent was used, which is the medium rate used by these governments for project evaluation.

2.3.3 Data sources

Namibia only developed its own national accounts after Independence in 1990, so there is no time series of mining surveys. Part of the information necessary to calculate rent can be obtained from unpublished national accounts data: production and extraction costs for each mineral since 1990. However, the costs of capital cannot be easily calculated for each mineral because there is no time

series of fixed capital by mining company. (There is a times series of fixed capital for *all* mining in (Hartmann, 1986) but this did not adequately distinguish different minerals.) A company survey was carried out to develop the time series, which is now updated with information about annual investment obtained from surveys by Namibia's Central Bureau of Statistics.

Mineral prices can fluctuate a great deal from one year to the next, so the value of mineral assets is not always best represented by the per unit rent in any single year. In order to reduce volatility and better represent the longer-term value of mineral assets, a number of countries, including Australia and Canada, use a multiple-year moving average per unit rent in calculating asset values. To better reflect the longer-term value of mineral assets, a 5-year lagged moving average of the unit rent is used for the mineral accounts.

2.3.4 Constant value asset accounts

As with many economic variables, in order to assess trends over time, values must be converted to constant value measures. There are two approaches to estimating the constant value of mineral assets. One approach, used by the Australian Bureau of Statistics for minerals treats the annual unit rent as the price of the asset *in situ.* Constant price mineral accounts are then obtained by applying the prices for the benchmark year to physical accounts throughout the times series (Johnson, ABS, pers. comm.). An alternative, income-based approach, under consideration by Statistics Canada (Gravel, pers. comm.), deflates current-price unit rent using the GDP deflator to represent the changing purchasing power of rent over time, similar to deflating financial assets or wages. Informal discussions with other economists and national accountants indicate more support for the income-oriented approach, so that is the method applied here. (See Lange, 2002b for further discussion of this issue and its implications for estimates of constant value natural capital.)

3. MINERAL ACCOUNTS FOR DIAMONDS, URANIUM AND GOLD

3.1 Physical accounts for minerals

For Namibia, only extraction can be reported for each mineral (Table 3). However, since DeBeers made public its estimates of reserves since 1999, the full accounts for those years are reported (Table 4). The growth of reserves between 1999 and 2000 indicates further exploration and development of off-shore diamond mining. Diamond extraction fell from 1980 to 1997 and began to recover since 1998 with the development of offshore diamond mines. Gold production increased somewhat after the initial development of the mine. Annual uranium production has declined continuously since 1980, due to the poor state of world demand. Rössing Uranium is currently operating at roughly 75 per cent of capacity (USGS, 2001) and prospects are not good for an increase in production in future years.

Table 3 Extraction of minerals in Namibia, 1980–2001

	Diamonds (million carats)	Gold (tons)	Uranium (thousands of tons)
1980	1.3		5.5
1981	1.0		5.3
1982	0.8		5.1
1983	0.8		5.2
1984	0.7		4.9
1985	0.6		4.4
1986	1.0		4.6
1987	0.8		4.8
1988	0.9		4.9
1989	0.8		4.2
1990	0.6		4.3
1991	0.8		3.3
1992	0.9		2.3
1993	0.6	2.0	2.3
1994	0.7	2.3	2.6
1995	0.6	2.0	2.9
1996	0.7	2.1	3.5
1997	0.8	2.5	4.1
1998	1.5	1.9	3.3
1999	1.6	2.0	3.2
2000	1.5	2.4	3.2
2001	1.6	2.9	2.6

Source: Ministry of Mines and Energy, 2002; USGS, 2001; World Diamond Council, 2001; World Nuclear Association, 2001.

Table 4 Physical accounts for diamonds, 1999–2001

	1999	2000	2001
Opening stock	4.8	7.0	16.2
Extraction	1.3	1.3	1.4
New discoveries and Other volume changes	3.5	10.5	Na
Closing stock	7.0	16.2	Na

Na: Not available.
Source: Author's calculations based on DeBeers, 1999; 2000.

3.2 Resource rent and the monetary accounts for minerals

3.2.1 Resource rent

The mining sector has generated substantial amounts of resource rent, mostly from diamonds (Table 5, See Appendix 1 for calculations).[2] In all years, diamond rent is positive and a large component of total mining rent. In some years diamond rent even surpasses total rent. This occurs in years when rents for other minerals (not reported here) are negative, i.e. mining companies do not earn enough to cover their full capital costs including a normal profit. Indeed, in 1993 and 1995, these losses were large enough to swamp the positive diamond rents and, as a result, rent for the entire industry was negative.

3.2.2 Sensitivity analysis

Calculation of rent requires an assumption about the rate of return used to calculate normal profit. To provide a sensitivity analysis of the assumption about a 10 per cent return to fixed capital, rent was also calculated assuming a 20 per cent return. For diamond mining, an increase in the return to capital to 20 per cent reduces rent by an average of 26 per cent over the period – less in the 1980's and more in recent years, which reflects the increasing capital intensity of diamond mining. For all mining together, the picture is more complex, reflecting different characteristics for different mining activities. Over the period, rent is 43 per cent lower for a 20 per cent rate of return to capital than for a 10 per cent return. Perhaps more importantly, a higher return to capital pushes most mining operations over the edge into unprofitability. At the higher cost of capital, total mining rents are negative (earning less than the cost of capital, less than normal profits) in 13 out of the past 22 years, and in 10 out of the last 12 years since Independence.

[2] Because more than one company is engaged in diamond mining, the rent can be reported. Rent for uranium and gold, each mined by a single company, cannot be reported separately.

Table 5 Resource rent from mining in Namibia and, 1980–2001 ($N millions)

	Rent for a return on fixed capital of 10%		Rent for a return on fixed investment of 20%	
	All Mining	Diamonds	All Mining	Diamonds
1980	339	281	250	258
1981	124	93	25	67
1982	105	57	-7	31
1983	74	86	-47	59
1984	108	66	-15	39
1985	382	159	250	132
1986	376	199	218	168
1987	206	201	35	165
1988	441	414	249	371
1989	548	466	324	412
1990	121	241	-134	167
1991	74	370	-190	293
1992	48	343	-229	257
1993	-246	150	-545	51
1994	135	400	-181	291
1995	-153	237	-495	115
1996	248	595	-138	446
1997	323	590	-98	424
1998	314	655	-138	486
1999	338	935	-158	741
2000	844	1093	288	860
2001	1483	1941	852	1677

NB: All mining includes all mining activities, not just the three (diamonds, uranium, gold) for which asset accounts are constructed. Figures for 2001 are provisional.
Source: Author's calculations based on methods and data sources described in Section 2.

Clearly, the estimate of rent (and, as a consequence, of mineral asset value) is quite sensitive to assumptions about the return on fixed capital. Analysis of rents from Botswana's mining industry also showed sensitivity to the rate of return to fixed capital, but the sensitivity varied a great deal among the three minerals that account for 99 per cent of Botswana's diamond mining (Lange, 2001; Lange and Hassan, 2003). Diamond mining, accounting for roughly 95 per cent of mining GDP, was not very sensitive: an increase of the return to capital to 20 per cent reduced rent by roughly 10 per cent, but copper–nickel and coal were highly sensitive. A 20 per cent return to capital could reduce the already-low rent by a third or more.

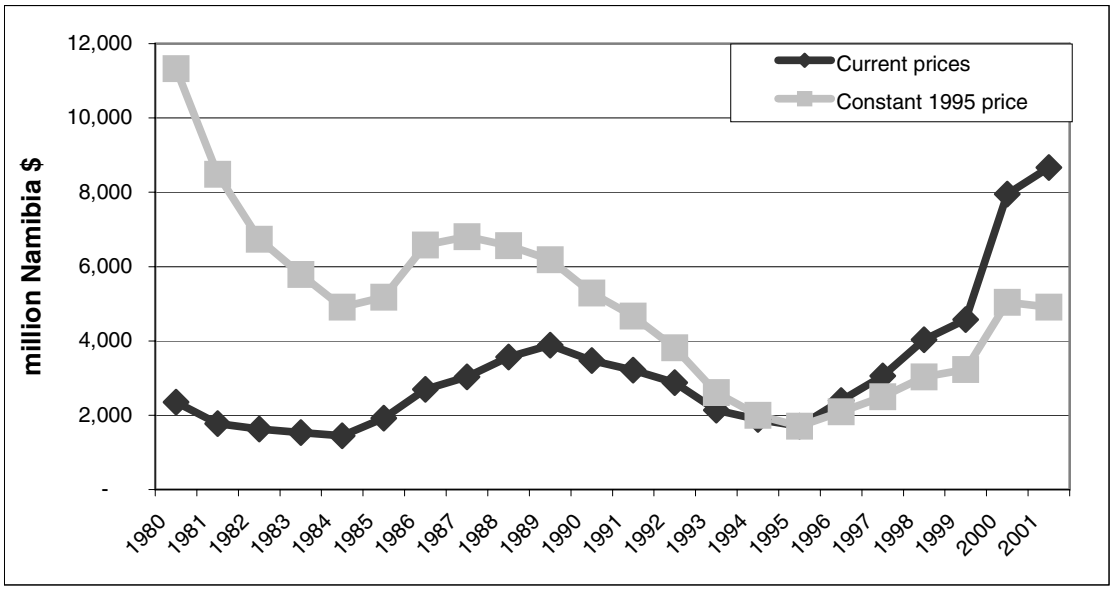
3.2.3 Monetary accounts

Figure 3 shows the asset value of minerals in current and constant 1995 prices. (The separate accounts for each mineral cannot be reported. The complete accounts are given in Appendix 1.) At first glance, it appears that Namibia's mineral wealth has increased enormously from N$2.4 billion

in 1980 to N$8.6 billion in 2001. However, adjusted for inflation, the real value of mineral wealth has instead declined by 57 per cent, from N$11.3 billion to N$4.9 billion in constant 1995 prices.

A decline in mineral wealth over time is not unusual because the physical reserves of non-renewable resources, which in effect constitute an inventory of wealth, are being depleted through extraction. A decline in wealth can be reversed when new discoveries or other volume changes are sufficient to offset depletion, which appears to account for the increase in real wealth in the late 1990s. Wealth can also increase when cheaper production costs or increases in market prices for minerals result in an increase in rent. Although the exhaustion of mineral wealth can be delayed, eventually, non-renewable resources will be depleted. The inevitability of this outcome suggests that countries depending on mineral wealth must manage their resources differently from countries that are not heavily dependent on non-renewable resources. This issue is taken up in the following section.

Figure 3 Mineral assets in current and constant prices, 1980– 2001



Source: Appendix Table A1.

4. POLICY IMPLICATIONS FOR RESOURCE MANAGEMENT

Non-renewable resources like minerals will eventually be depleted, and the employment and incomes generated by this activity will come to an end. It is especially important that resource rents from minerals be invested in other kinds of economic activity, which can replace the employment and income from the mineral-based industries once they are exhausted. In this way, exploitation of minerals can be *economically* sustainable – because it creates a permanent source of income – even though non-renewable resources are, by definition, not biologically sustainable. This principle for sustainable development, of reinvesting rent from non-renewable resources in other assets, is known as the Solow–Hartwick Rule (Hartwick, 1977; Solow, 1974; 1986).

In Namibia, as in most other countries, mineral assets are the property of the state. As the owner of the resource, the government is entitled to a portion of the resource rent, even when private operators exploit the resource, much like a landowner may rent grazing land. Rent that is not recovered by government accrues as 'windfall' profits to mining companies. There is no guarantee that mining companies will reinvest the rent in the host country, especially if the mining operators

are foreigners and there are relatively few investment opportunities in the host country. As the owner of the resource, the government bears the responsibility for reinvestment of the rent. This requires:

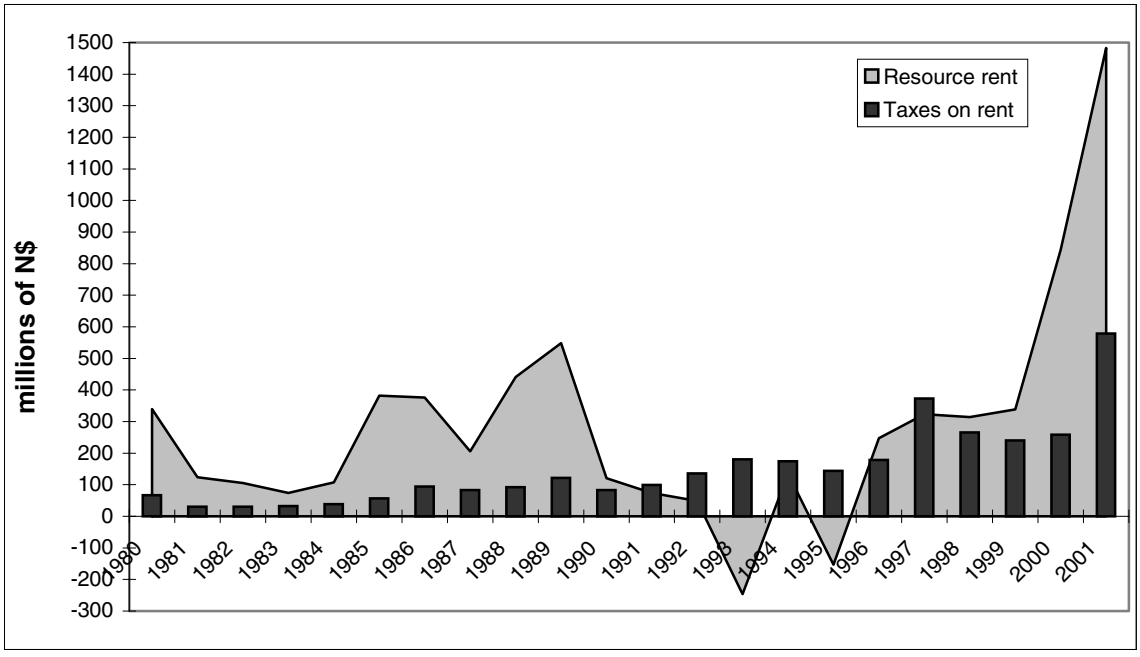
- recovery of a significant portion of the resource rent; and
- a policy of reinvestment of the rent in other assets: human capital (e.g. education and health), manufactured capital (e.g. public infrastructure), natural capital, or foreign financial assets (which represent claims on the capital of other countries).

4.1 Recovery of resource rent

Like many countries, Namibia levies a number taxes and fees on its mineral industry. Some of these are ordinary corporate profit taxes, but others are designed specifically to capture the 'excess profits,' that is, the rents, generated by mining. (Description of the different taxes and determination of which constitute taxes on rent are discussed in Appendix 1.) Over the past two decades, government has recovered an average of 52 per cent of the rent generated by all mining, but rent recovery has varied enormously from year to year (Figure 4). Perhaps because of the volatility, government has levied taxes designed to recover rent only on diamond mining; taxes paid by other mining operations fall within the range of normal corporate taxes on income (see Appendix 1). As a share of diamond rent, taxes have been considerably lower, averaging 42 per cent over the past two decades. Since Independence, rent recovery has increased slightly to 45 per cent.

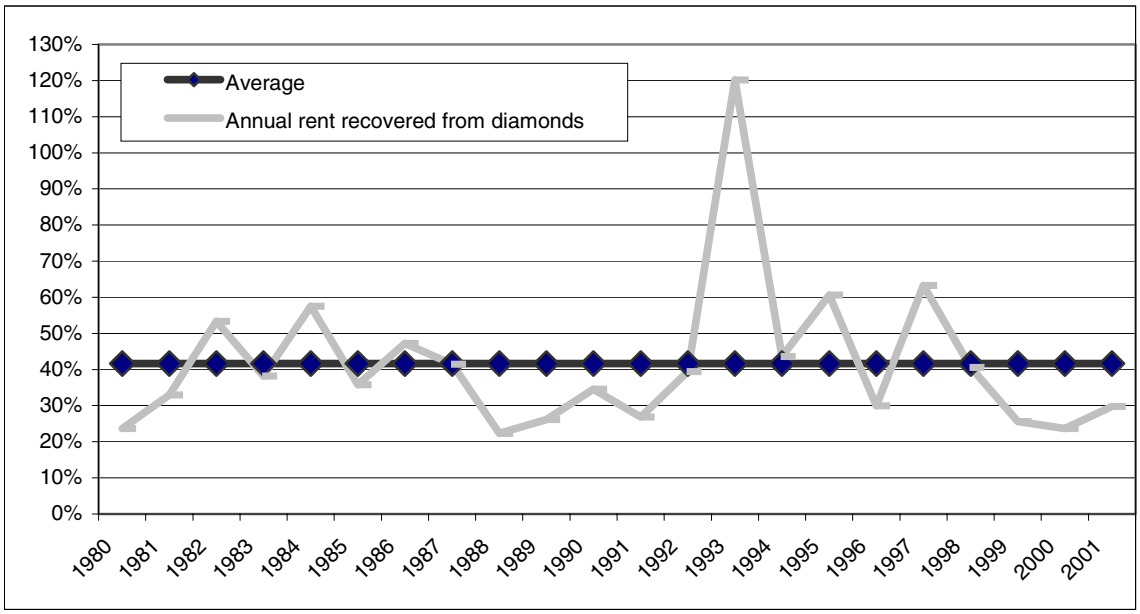
Whether this degree of rent recovery is sufficient is difficult to determine. When rent is so volatile, it is not feasible to attempt full rent recovery, and government must be careful not to set taxes so high as to discourage investment. By comparison, the government of Botswana has recovered a greater share of resource rent – averaging 76 per cent over the period 1980 to 1997 (Lange and Wright, forthcoming). However, diamonds generate more than 95 per cent of the rent, and diamond rent has been much more stable in Botswana over the past two decades, which makes it much easier to establish appropriate tax regimes.

Figure 4 Rent recovery from mining in Namibia, 1980–2001



Source: Rent from Table 5; taxes from Table A3.

Figure 5 Rent recovery as a share of rents from diamond mining, 1980–2001



Sources: Rent from Table 5; taxes from Table A3.

4.2 4.2 Reinvestment of resource rent to maintain national wealth

While the Hartwick–Solow Rule provides general theoretical guidelines for reinvesting mineral rents, there are few specific rules for determining the amount of rent that must be reinvested. Namibia, like many other resource-rich countries, does not have an explicit policy for reinvestment of resource rent. Prior to Independence, the lack of a reinvestment policy could be attributed to disinterest in providing for the future of the majority of Namibia's population. However, even after independence, Namibia has not explicitly reversed this policy.

It is useful to consider one country that has developed an explicit policy regarding management of resource rent, Botswana. Recognising that the revenues from diamonds represented mainly asset sales rather than value added in production, the government of Botswana saw the need for reinvestment of these revenues in order to maintain economic growth. Government can reinvest rents in public sector capital (infrastructure), human capital (education and health care), or in foreign financial assets, which yield an annual income. Of course, if rents are used for public consumption rather than reinvestment, then national wealth declines over time. Botswana developed an indicator, the Sustainable Budget Index (SBI), to monitor whether the mineral revenues it collects are being used in a manner that promotes sustainable development, that is, whether mineral wealth is being transformed into other assets (Box 3).

The SBI monitors reinvestment of rents by showing the share of public consumption that is paid for out of non-mineral revenues. According to its rule (SBI < 1.0) public consumption should not use any mineral revenues, implicitly requiring that all mineral revenues be used *only* for investment. Until the mid-1990's, the SBI was well below 1.0 and all mineral revenues were reinvested (Figure 6). Since then, the SBI has increased, surpassing 1.0 in 2001. Indications are that it will continue to surpass 1.0 by a small amount in the next few years at least.

Box 3 Sustainable Budget Index (SBI)

Sustainable development in economies dependent on non-renewable resources requires reinvestment of resource rents in other assets to offset depletion of mineral assets. The SBI is an indicator that monitors whether government is reinvesting mineral rents or using them for public consumption. SBI is the ratio of public consumption (non-investment expenditures) to recurrent (non-mineral) revenues.

$$SBI = \frac{Govt.Spending \ \ (non\text{-}investment)}{Govt.\mathrm{Re}venue \ \ (recurrent)}$$

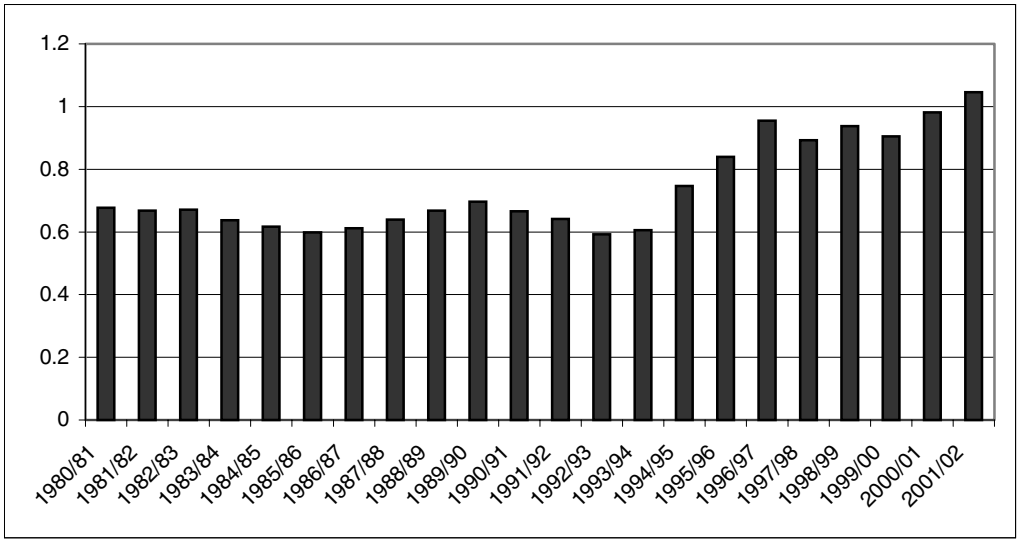
SBI < 1.0 means that all resource rent is used for investment in public sector and human capital.

SBI > 1.0 means that mineral wealth is being liquidated to pay for current consumption, which is fiscally unsustainable in the long run.

To account for investment in human capital, non-investment expenditures on education and health are excluded from the numerator. See Lange and Wright (forthcoming) for further discussion of the SBI and its use in Botswana.

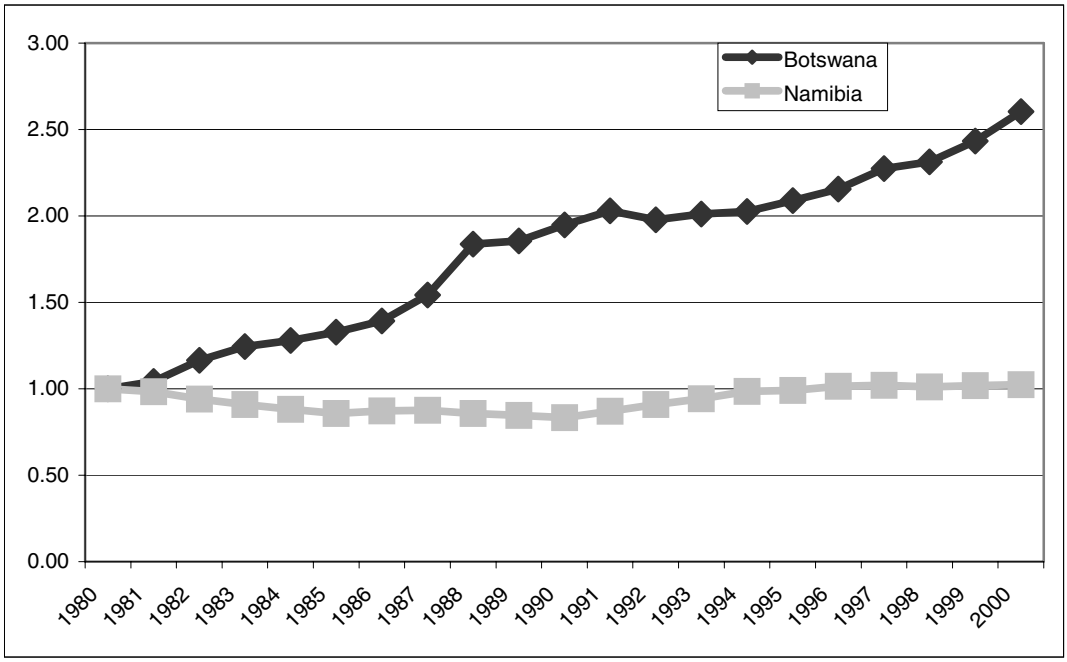
While there are a number of shortcomings to the SBI, there is no doubt that it has served Botswana very well in the process of economic development. Its real, per capita income has increased substantially over time, in contrast to that of Namibia's (Figure 7). Real, per capita income in Botswana's has grown steadily, doubling in the decade from 1980 to 1991, and growing an additional 60 per cent in the 1990s. Namibia's real, per capita GDP is roughly the same in 2000 as it was twenty years ago in 1980. However, this observation masks considerable economic growth after Independence. Given the decline of GDP by 17 per cent in the 1980's, recovery to the 1980 level of per capita income represents a considerable achievement, although growth rates are not nearly as high as in Botswana.

Figure 6 The Sustainable Budget Index of Botswana, 1980–2001



NB: SBI < 1.0 means that all mineral revenues are reinvested rather than used for public consumption. SBI > 1.0 means that public consumption is funded by mineral revenues.
Source: Lange and Wright, forthcoming.

Figure 7 Per capita GDP growth in Botswana and Namibia, 1980–2000



Source: Botswana: Bank of Botswana, 2001; unpublished data. Namibia: CBS, 1996; 2001.

5. CONCLUSIONS

Mineral wealth can provide countries with a tremendous opportunity for economic development by providing the funding for investment and growth. Many countries, however, have squandered this gift from nature and end up no better off than countries without an abundance of natural capital. Using minerals to build a sustainable economy requires:

- policies that maximise resource rent generated by mining;
- recovery of resource rent by an agency able and willing to reinvest rent;
- reinvestment of rent in other assets that are capable of generating income and employment once resources are exhausted, such as human capital, public infrastructure and manufactured capital

Maximisation of resource rent is most often achieved through exploitation of minerals by large-scale commercial operators, a policy followed in Namibia. With respect to the second criteria, recovery of resource rent, Namibia has been moderately successful, recovering an average of about 40 per cent of diamond rents over the past 20 years. This is less than the rate of recovery achieved in Botswana, but not unreasonable given the greater volatility of mineral rents in Namibia.

The critical factor for sustainable economic development is the third criteria, reinvestment of the rent. Most resource-rich countries recover a substantial portion of the rent through taxes. However, the rent is then used for current consumption rather than to build the wealth that guarantees the livelihoods of future generations as well. Countries that have been successful in reinvesting rent usually have explicit policies to guide them. Botswana's Sustainable Budget Index is one example, but by no means the only one[3].

Much of Namibia's mineral wealth was extracted prior to 1990 and was not used for the betterment of all its citizens. Since Independence, Namibia has carefully considered how mining may

[3] Other examples, however, are mostly in industrialised countries, e.g. Alberta, Canada and Alaska, United States. For further discussion of this, see Lange and Wright (forthcoming).

contribute to current employment and the economy of specific regions of the country. This has, in part, resulted in the recovery of economic growth since 1990. But Namibia has yet to develop a policy that addresses how mineral wealth can contribute to long-term sustainable development, i.e. how it can be used to build national wealth. The tremendous demands being placed on the economy by the HIV/AIDS epidemic make this an even more urgent.

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APPENDIX 1

This appendix has three sections. The first section provides the data used to calculate resource rent and goes through the calculation for one year to demonstrate how the formulas are applied. The second section presents the monetary accounts. The final section discusses all the taxes levied on the mining industry and describes what portion can be considered tax on resource rent.

A.1 Calculation of resource rent for mining

This section demonstrates how resource rent is calculated and presents the monetary assets for minerals. Using the formula in Box 1 and the data from the national accounts reported in Table A1, the rent in 1980 for a 10 per cent return to fixed capital stock can be calculated as:

	Item number and description	Value (millions of N$)
1.0	Output minus	913
2.0	Intermediate consumption	-280
3.1	Net taxes	- 1
3.2	Compensation of employees	-141
4.0	Consumption of Fixed Capital (CFC)	- 64
6.1	10% return to Capital Stock (0.1* 891)	- 89
	= RENT	=339

Table A1 Calculating resource rent for mining, 1980 to 2001

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1.0 Output	913	706	742	773	862	1228	1500	1418	1797	2236	2350
2.0 Intermediate consumption	280	248	s272	292	342	382	574	611	653	853	1266
3.0 Value added	633	458	470	481	520	847	927	807	1144	1382	1084
3.1 Net taxes	1	1	1	1	1	1	2	2	3	3	4
3.2 Compensation of employees	141	163	167	190	189	215	239	253	305	364	435
3.3 GOS	491	293	301	290	330	630	686	552	836	1015	646
Capital Costs											
4.0 CFC	64	72	85	96	101	117	153	177	206	247	274
5.0 Capital Stock	891	987	1122	1209	1224	1324	1582	1709	1919	2237	2547
6.1 10% return	89	99	112	121	122	132	158	171	192	224	255
6.2 20% return	178	197	224	242	245	265	316	342	384	447	509
Resource rent											
7.1 10% return	339	124	105	74	108	382	376	206	441	548	121
7.2 20% return	250	25	-7	-47	-15	250	218	35	249	324	-134

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1.0 Output	2005	2167	1728	2327	2298	2977	3311	3458	3808	4546	5721
2.0 Intermediate consumption	901	1056	909	1077	1240	1438	1582	1623	1859	1935	2232
3.0 Value added	1104	1112	819	1250	1058	1539	1729	1835	1949	2610	3489
3.1 Net taxes	5	5	4	5	7	7	8	10	10	11	12
3.2 Compensation of Employees	482	494	469	484	524	535	577	622	618	651	731
3.3 GOS	617	613	346	761	528	997	1144	1204	1321	1949	2746
Capital Costs											
4.0 CFC	284	292	297	316	345	371	408	447	497	560	645
5.0 Capital Stock	2632	2773	2990	3153	3418	3855	4210	4525	4960	5562	6307
6.1 10% return	263	277	299	315	342	386	421	452	496	556	631
6.2 20% return	526	555	598	631	684	771	842	905	992	1112	1261
Resource rent											
7.1 10% return	74	48	-246	135	-153	248	323	314	338	844	1483
7.2 20% return	-190	-229	-545	-181	-495	-138	-98	-138	-158	288	852

NB: Figures for individual minerals cannot be published. Figures for 2001 are provisional.
Source: Unpublished data from the national accounts compiled by the Central Bureau of Statistics.

A.2 Monetary accounts for minerals

Table A2 Monetary asset accounts for minerals in Namibia, 1980 to 2001 ($N millions)

A. Current Prices

	Opening Stocks	Extraction	New discoveries + Other volume changes	Revaluation	Closing stocks
1980	2,625	283	10	0	2,352
1981	2,352	158	66	-483	1,778
1982	1,778	103	-39	-11	1,624
1983	1,624	105	11	3	1,534
1984	1,534	83	-13	14	1,451
1985	1,451	81	231	322	1,923
1986	1,923	151	-13	936	2,695
1987	2,695	159	142	359	3,036
1988	3,036	239	32	738	3,567
1989	3,567	276	-234	826	3,883
1990	3,883	248	-75	-84	3,475
1991	3,475	354	58	34	3,212
1992	3,212	396	94	-32	2,878
1993	2,878	268	30	-504	2,136
1994	2,136	307	46	14	1,888
1995	1,888	268	337	-248	1,709
1996	1,709	373	351	711	2,397
1997	2,397	444	504	603	3,061
1998	3,060	884	883	974	4,034
1999	4,034	949	2,095	-605	4,575
2000	4,575	1,037	6,984	-2,570	7,952
2001	7,952	1,224	11	1,929	8,668

B. Constant 1995 Prices

	Opening Stocks	Extraction	New discoveries + Other volume changes	Revaluation	Closing stocks
1980	12,644	1,365	50	0	11,330
1981	11,223	752	314	-2,304	8,481
1982	7,372	428	-162	-45	6,737
1983	6,135	396	41	13	5,793
1984	5,188	281	-45	46	4,908
1985	3,909	219	622	868	5,181
1986	4,698	370	-32	2,286	6,583
1987	6,040	356	318	804	6,806
1988	5,588	440	59	1,358	6,565
1989	5,685	440	-372	1,316	6,188
1990	5,910	378	-114	-128	5,289
1991	5,052	515	84	49	4,670
1992	4,262	526	125	-43	3,820
1993	3,519	328	37	-617	2,611
1994	2,258	325	48	15	1,996
1995	1,888	268	337	-248	1,709
1996	1,492	326	306	621	2,094
1997	1,956	362	411	491	2,496
1998	2,299	664	664	732	3,031
1999	2,845	669	1,477	-427	3,226
2000	2,899	657	4,426	-1,628	5,039
2001	4,508	694	6	1,094	4,914

NB: Figures for individual minerals cannot be published. Figures for 2001 are provisional.
Source: Author's calculations based on methodology and data described in Section 2.

A.3 Taxes on resource rent

Table A3 shows the total taxes paid by the mining industry from 1980 to 2001. There are various forms of taxes and not all taxes can be considered taxes on rent. This section describes how the portion of mining taxes that can be considered taxes on rent has been calculated.

Taxes on production (column 1) include fees levied for government services related to mining activity, such as licensing and registration. They are not designed to capture rent.

Diamond export duties (column 4), later replaced by the *diamond export levy*[4] (column 5), are considered taxes on rent.

Taxes on income and profits (columns 2, 3, 6). All companies in all industries pay some tax on their income and the normal rate of taxation should not be considered a tax on rent. The normal corporate tax rate is presently 35%. Only tax rates in excess of the normal rate are considered a tax on rent. The non-diamond mining companies pay the normal corporate income tax rate, so they are, in effect, paying no tax on rent. Diamond mining, however, is taxed at a higher rate, 55%, due to the excess profits – that is, the rents – earned by these companies. So the portion of income tax paid by diamond mining above the 35% normal tax rate is considered a tax on rent. This portion, which amounts to 36% of diamond income tax, is shown in column 3.

Taxes on resource rent (column 8) is the sum of diamond export duties, diamond royalties and the portion of diamond income tax that is a tax on rent.

[4] The export levy is 10% of the value of diamond exports.

Table A3 Taxes on resource rent in Namibia, 1980–2001 ($N millions)

	DIAMONDS					OTHER MINING	ALL TAXES ON INCOME, PROFIT, RENT	
		Income and profit tax						
	Taxes on Production	Full tax	Tax on resource rent	Export duties	Diamond royalties	Income and profit	Total taxes	Taxes on resource rent
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			36% of col 2				Cols 1+2+4+5+6	Cols 3+4+5
1980	0.8	102.4	37.2	29.3		16.7	149.2	66.5
1981	0.9	35.1	12.8	17.7		2	55.7	30.5
1982	1.2	24.3	8.8	21.7		2.3	49.5	30.5
1983	1.3	26.6	9.7	23.1		37.1	88.1	32.8
1984	1.3	46.9	17.1	21.1		65.4	134.7	38.2
1985	1.3	49.8	18.1	38.8		153.2	243.1	56.9
1986	1.8	120.9	44.0	50.2		146	318.9	94.2
1987	2.1	114.1	41.5	41.8		158.9	316.9	83.3
1988	2.6	77.6	28.2	64.2		180.1	324.5	92.4
1989	3.0	131.6	47.9	73.9		157.3	365.8	121.8
1990	3.6	62.3	22.7	60.5		75.8	202.2	83.2
1991	4.6	23.3	8.5	90.9		26.1	144.9	99.4
1992	5.4	115.1	41.9	93.6		2.6	216.7	135.5
1993	3.6	181.5	66.0	114.2		5.8	305.1	180.2
1994	4.7	126	45.8	3.1	125.4	37.5	296.7	174.3
1995	6.5	61.8	22.5		121.4	18.6	208.3	143.8
1996	7.3	89.9	32.7		145.7	44.8	287.7	178.4
1997	7.8	505.0	183.6		189.3	28.6	730.7	373.0
1998	9.7	161.4	58.7		206.9	19.2	397.3	265.6
1999	10.4	142.7	51.9		188.0	211.7	552.8	239.9
2000	11.1	185.0	67.3		191.5	65.0	452.6	258.8
2001	11.9	475.0	172.7		405.7	55.0	947.6	578.4

NB: Diamond export duties were replaced by diamond royalties after 1994. Taxes on income and profit for 2000–2001 are estimated.
Source: Ministry of Finance (various years).

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